Amendments to the Specification

Please amend the paragraph beginning at page 4, line 13, to the following:

--Figure 3 shows a second example method 300. This method is referred to as a closed-loop architecture. In this method, the input video bitstream <u>301</u> is again partially decoded, i.e., macroblocks of the input bitstream are variable-length decoded (VLD) 310, and inverse quantized 320 with Q_1 to yield discrete cosine transform (DCT) coefficients 321. In contrast to the first example method described above, correction DCT coefficients 332 are added 330 to the incoming DCT coefficients 321 to compensate for the mismatch produced by re-quantization. This correction improves the quality of the reference frames that will eventually be used for decoding. After the correction has been added, the newly formed blocks are re-quantized 340 with Q_2 to satisfy a new rate, and variable-length coded 350, as before. Note, again Q_1 and Q_2 are rate based.--

Please amend the paragraph beginning at page 5, line 1, to the following:

--To obtain the correction component 332, the re-quantized DCT coefficients are inverse quantized 360 and subtracted 370 from the original partially decoded DCT coefficients. This difference is transformed to the spatial domain via an inverse DCT (IDCT) 365 and stored into a frame memory 380. The motion vectors 381 associated with each incoming block are then used to recall the corresponding difference blocks, such as in motion compensation ~~290~~ <u>390</u>. The corresponding blocks are then transformed via the DCT ~~332~~ <u>331</u>to yield the correction component. A derivation of the method shown in Figure 3 is described in "A frequency domain video transcoder for dynamic bit-rate reduction of MPEG-2 bitstreams," by Assuncao et al., IEEE Transactions on Circuits and Systems for Video Technology, pp. 953-957, 1998.--

Please amend the paragraph beginning at page 11, line 11, to the following:

--Figure ~~11a~~ <u>11A</u> is a block diagram of a second closed-loop transcoder for spatial resolution reduction with drift compensation in the original resolution according to the invention;--

Please amend the paragraph beginning at page 11, line 15, to the following:

--Figure ~~11b~~ 11B is a block diagram of a third closed-loop transcoder for spatial resolution reduction with drift compensation in the original resolution according to the invention;--

Please amend the paragraph beginning at page 13, line 14, to the following:

--A first alternative, see Figure 9, uses an open-loop architecture, while the other three alternatives, Figures 10 and ~~11a-b~~ 11A-B, correspond to closed-loop architectures that provide a means of compensating drift incurred by down-sampling, re-quantization and motion vector truncation. One of the closed-loop architectures performs this compensation in the reduced resolution, while the others perform this compensation in the original resolution in the DCT domain for better quality.--

Please amend the paragraph beginning at page 13, line 22, to the following:

--As will be described in greater detail below, the open-loop architecture of Figure 9 is of low complexity. There is no reconstruction loop, no DCT/IDCT blocks, no frame store, and the quality is reasonable for low picture resolution, and bit-rates. This architecture is suitable for Internet applications and software implementations. The first closed-loop architecture of Figure 10 is also of moderate complexity. It includes a reconstruction loop, IDCT/DCT blocks, and a frame store. Here, the quality can be improved with drift compensation in **reduced** resolution domain. The second closed-loop architecture of Figure ~~11a~~ 11A is of moderate complexity. It includes a reconstruction loop, IDCT/DCT blocks, and a frame store. The quality can be improved with drift compensation in the **original** resolution domain, and does require up-sampling of the reduced resolution frames. The third closed loop architecture uses a correction signal obtained in the reduced resolution domain.--

Please amend the paragraph beginning at page 17, line 7, to the following:

--Moreover, if access to the content stored on the HDD 830 is desired by a low-resolution external client 806 via the external network ~~802~~ 703, then the transcoder 850 can also be used to deliver low-resolution multimedia content to this client.--

Please amend the paragraph beginning at page 18, line 11, to the following:

--The signal g_n^2 is subject to the DCT 440, then quantized 450 with quantization parameter Q_2. The quantized signal c_{out} 451 is variable length coded 460 and written to the transcoded bitstream 402. As part of the motion compensation loop in the encoder, c_{out} is inverse quantized 470 and subject to the IDCT 480. The reduced resolution reference signal y_n^2 481 is stored into the frame buffer 490 as the reference signal for future frame predictions.--

Please amend the paragraph beginning at page 22, line 23, to the following:

--In this architecture, the incoming signal 1001 is variable length decoded 1110 to yield quantized DCT coefficients 1111, and full resolution motion vectors, mv_f 1112. The quantized DCT coefficients 1111 are inverse quantized 1130, with quantizer Q_1, to yield signal E_n^1 1131. This signal is then subject to the group of blocks processor 1300. After group of blocks processing 1300, an original-resolution drift-compensating signal 1151 is added 1160 to the residual 1141 in the DCT domain. The signal 1162 is then down-sampled 1150, and the down-sampled signal 1161 is quantized 1170 with quantizer Q_2. Finally, the reduced resolution re-quantized DCT coefficients 1171, and motion vectors 1121 obtained by MV mapping 1120 are variable length coded 1180, and written to the transcoded bitstream 1102.--

Please amend the paragraph beginning at page 23, line 10, to the following:

--The reference frame from which the original-resolution drift-compensating signal 1151 is generated by an inverse quantization 1190 of the re-quantizer residual G_n^2 1171, which is then up-sampled 1191. Here, *after* the up-sampling the up-sampled signal is subtracted 1192 from the *original* resolution residual ~~1161~~ 1141. This difference signal is subject to the IDCT 1194, and added 1195 to the original-resolution predictive component 1196 of the previous macroblock. This new signal represents the difference $(x_{n-1}^1 - x_{n-1}^2)$ 1197, and is used as the reference for motion compensation of the current macroblock in the original resolution.--

Please amend the paragraph beginning at page 24, line 4, to the following:

--Figure ~~11b~~ 11B shows an alternative embodiment of the closed loop architecture of Figure ~~11a~~ 11A. Here, the output of the inverse quantization 1190 of the re-quantizer residual G_n^2 1172 is subtracted 1192 from the *reduced* resolution signal *before* up-sampling 1191.--

Please amend the paragraph beginning at page 24, line 17, to the following:

--Because the up-sampled signal is not considered in the future decoding of the transcoded bitstream, it is reasonable to exclude any error measured by consecutive down-sampling and up-sampling in the drift compensation signal. However, up-sampling is still employed for two reasons: to make use of the full-resolution motion vectors 1121 obtained by MV mapping 1120 to avoid any further approximation, and so that the drift compensating signal is in the original resolution and can be added 1160 to the incoming residual ~~1161~~ 1141 before down-sampling 1150.--

Please amend the paragraph beginning at page 26, line 7, to the following:

~~--Figure 1300~~ Figure 13 shows the components of the group of blocks processor 1300. For a selected group of mixed blocks 1301, the group of blocks processor performs mode mapping 1310, motion vector modification

1320, and DCT coefficient modification 1330 to produce an output non-mixed block 1302. Given that the group of blocks 1301 has been identified, the modes of the macroblocks are modified so that all macroblocks are identical. This is done according to a pre-specified strategy to match the modes of each sub-block in a reduced resolution block.--

Please amend the paragraph beginning at page 32, line 11, to the following:

--The above filters are useful components to efficiently implement the architecture shown in ~~Figure 11~~ Figure 11A that requires up-sampling. More generally, the filters derived here can be applied to any system that requires arithmetic operations on up-sampled DCT data, with or without resolution reduction or drift compensation.--

Please amend the paragraph beginning at page 33, line 20, to the following:

--The above method of up-sampling in the DCT domain is not suitable for use in the transcoder described in this invention. In Figure ~~11a~~ 11A, up-sampled DCT data are subtracted from DCT data output from the mixed block processor 1300. The two DCT data of the two blocks must have the same format. Therefore, a filter that can perform the up-sampling illustrated in Figure 15C is required. Here, the single $2^N x 2^N$ block 1502 is up-sampled 1540 to four $2^N x 2^N$ blocks 1550. Because such a filter has not yet been considered and does not exist in the known prior art, an expression for the 1D case is derived in the following.--

Please amend the paragraph beginning at page 35, line 2, to the following:

--Given the above, block E 1610 represents the up-sampled DCT block based on filtering C with X_u 1611, and e 1620 represents the up-sampled spatial domain block-based on filtering c with the x_u 1621 given by equation (12). Note that e and E are related through a 2N-pt DCT/IDCT 1630. The input-output relations of the filtered input are given by,

$$E_k = \sum_{q=0}^{N-1} C_q X_u(k,q); \quad 0 \le k \le 2N-1 \quad \text{, and} \tag{16a}$$

$$e_i = \sum_{j=0}^{N-1} c_j x_u(i,j); \quad 0 \le i \le N-1 \quad . \tag{16b}$$

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Please amend the paragraph beginning at page 35, line 10, to the following:

--As shown in Figure 16, the desired DCT blocks are denoted by A ~~1611~~ 1651 and B ~~1612~~ 1652. The aim of this derivation is to derive filters X_{ca} 1641 and X_{cb} 1642 that can be used to compute A and B directly from C, respectively.--